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* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] The wavelength-multiplexing lightwave-signal sending set characterized by to have two or more lightwave-signal transmitting means output the lightwave signal which put the sending signal on two or more light from which wavelength differs mutually non-become irregular, respectively, a wavelength-multiplexing means multiplex the lightwave signal of each wavelength outputted from two or more of said lightwave-signal transmitting means, and output a wavelength-multiplexing lightwave signal, and an optical branching means do branching n of said wavelength-multiplexing lightwave signal (n is two or more integers), and transmit to juxtaposition in n optical transmission lines.
[Claim 2] Two or more lightwave signal transmitting means to output the lightwave signal which put the sending signal on two or more light from which wavelength differs mutually non-become irregular, respectively, The lightwave signal of each wavelength outputted from said two or more lightwave signal transmitting means n branching, respectively Two or more optical branching means to carry out, The wavelength multiplexing lightwave signal sending set characterized by having n wavelength multiplexing means to multiplex the lightwave signal of each wavelength of which n branching was done with said two or more optical branching means, respectively, to generate n wavelength multiplexing lightwave signals, and to transmit to juxtaposition in n optical transmission lines.
[Claim 3] The 1st lightwave signal transmitting means which outputs the lightwave signal which put the sending signal on a light of predetermined wavelength non-become irregular, The lightwave signal of the predetermined wavelength outputted from said 1st lightwave signal transmitting means n branching The optical branching means to carry out, The 2nd lightwave signal transmitting means which outputs n lightwave signals which put the sending signal on n light of the same wavelength non-become irregular mutually, respectively unlike said predetermined wavelength, The wavelength multiplexing lightwave signal sending set characterized by having n wavelength multiplexing means to multiplex the lightwave signal of which n branching was done with said optical branching means, and n lightwave signals outputted from said 2nd lightwave signal transmitting means, respectively, to generate n wavelength multiplexing lightwave signals, and to transmit to juxtaposition in n optical transmission lines.

[Claim 4] It is the wavelength multiplexing lightwave signal sending set which said 1st lightwave signal transmitting means is a configuration which outputs two or more lightwave signals with which wavelength differs mutually in a wavelength multiplexing lightwave signal sending set according to claim 3, and said 2nd lightwave signal transmitting means makes n lightwave signals of the same wavelength 1 set, and is characterized by being the configuration which outputs the lightwave signal which is two or more sets from which wavelength differs mutually.
[Claim 5] A lightwave signal change means to choose one of the wavelength multiplexing lightwave signals transmitted to juxtaposition in n optical transmission lines, A wavelength demultiplexing means to separate spectrally into the lightwave signal of each wavelength the wavelength multiplexing lightwave signal chosen with said lightwave signal change means, Two or more lightwave signal receiving means to receive the lightwave signal of each of said wavelength, respectively, and to output two or more input signals, When a failure is in the wavelength multiplexing lightwave signal transmitted through the optical transmission line chosen with said lightwave signal change means, or the lightwave signal of each wavelength The wavelength multiplexing lightwave signal receiving set characterized by having the control means which controls said lightwave signal change means to choose the wavelength multiplexing lightwave signal transmitted in other optical transmission lines.
[Claim 6] n wavelength demultiplexing means to separate spectrally into the lightwave signal of each wavelength the wavelength multiplexing lightwave signal transmitted to juxtaposition in n optical transmission lines, respectively, A lightwave signal change means to choose one lightwave signal from the lightwave signal of each wavelength outputted from said n wavelength demultiplexing means for every wavelength, Two or more lightwave signal receiving means to receive the lightwave signal of each of said wavelength, respectively, and to output two or more input signals, The wavelength multiplexing lightwave signal receiving set characterized by having the control means which controls said lightwave signal change means to choose the lightwave signal transmitted in other optical transmission lines when a failure is in the lightwave signal of each wavelength chosen with said lightwave signal change means.
[Claim 7] n wavelength demultiplexing means to separate spectrally into the lightwave signal of each wavelength the wavelength multiplexing lightwave signal transmitted to juxtaposition in n optical transmission lines, respectively, The lightwave signal of each wavelength outputted from said n wavelength demultiplexing means is inputted. A lightwave signal change means to choose one lightwave signal for every wavelength about the wavelength of the 1st lightwave signal transmitting means according to claim 3, and to output the lightwave signal of each wavelength, respectively about the wavelength of the 2nd lightwave signal transmitting means according to claim 3, Two or more lightwave signal receiving means to receive the lightwave signal of each of said wavelength, respectively, and to output two or more input signals, The wavelength multiplexing lightwave signal receiving set characterized by having the control means which controls said lightwave signal change means to choose the lightwave signal transmitted in other optical transmission lines when a failure is in said lightwave signal of the wavelength of the 1st lightwave signal transmitting means chosen with said lightwave signal change means.
[Claim 8] The light wave length multiplex communication system characterized by being the configuration of having connected between a wavelength multiplexing lightwave signal sending set according to claim 1 or 2 and wavelength multiplexing lightwave signal receiving sets according to claim 5 or 6 through n optical transmission lines which carry out the parallel transmission of the wavelength multiplexing lightwave signal.

[Claim 9] The light wave length multiplex communication system characterized by being the configuration of having connected between a wavelength multiplexing lightwave signal sending set according to claim 3 or 4 and wavelength multiplexing lightwave signal receiving sets according to claim 7 through n optical transmission lines which carry out the parallel transmission of the wavelength multiplexing lightwave signal.
[Claim 10] The light wave length multiplex communication system characterized by having had the signal change means which changes the lightwave signal which puts said sending signal on said wavelength multiplexing lightwave signal sending set in a light wave length multiplex communication system according to claim 8 or 9, and having the signal change means which changes the input signal outputted to said wavelength multiplexing lightwave signal receiving set from said lightwave signal receiving means corresponding to the change of the signal change means of said wavelength multiplexing lightwave signal sending set.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention is changed to reserve wavelength, when a failure occurs in the lightwave signal of a certain wavelength among the lightwave signals by which light wave length multiplex transmission is carried out, and when a failure occurs in an optical transmission line, it relates to the wavelength multiplexing lightwave signal sending set, wavelength multiplexing lightwave signal receiving set, and light wave length multiplex communication system which change to a reserve optical transmission line and perform failure restoration.
[0002]
[Description of the Prior Art] In the optical transmission system as which high dependability is required, as shown in drawing 10 , it has the lightwave signal sending set 10, an optical transmission line 2, and two or more sets of lightwave signal receiving sets 30, and has composition changed using the switcher 4 by the side of a sending set, and the switcher 5 by the side of a receiving set. namely, -- usually -- the lightwave signal sending set 10-1, an optical transmission line 2-1, and the lightwave signal receiving set 30-1 -- present -- business -- it transmits and receives by using as a system, when a failure occurs in the either, switchers 4 and 5 are controlled using the control system which is not illustrated, and it changes to the lightwave

signal sending set 10-2 which constitutes a reserve system, an optical transmission line 2-2, and the lightwave signal receiving set 30-2.

[0003] Moreover, in a light wave length multiplex communication system, since a signal which is different on two or more wavelength can be transmitted, two or more channels can be formed in one optical transmission line. Therefore, when the sending circuit or receiving circuit of a certain wavelength breaks down, a communication link can be continued using the same optical transmission line only by changing to other sending circuits and receiving circuits of wavelength. However, to failure of an optical transmission line, it is necessary to equip a duplex with an optical transmission line like the case of drawing 10 .

[0004] Drawing 11 shows the example of the light wave length multiplex communication structure of a system as which high dependability is required. drawing -- setting -- the wavelength multiplexing lightwave signal sending set 1-1, an optical transmission line 2-1, and the wavelength multiplexing lightwave signal receiving set 3-1 -- present -- business -- constituting a system, the wavelength multiplexing lightwave signal sending set 1-2, an optical transmission line 2-2, and the wavelength multiplexing lightwave signal receiving set 3-2 constitute a reserve system. The wavelength multiplexing lightwave signal sending set 1 is constituted by the wavelength multiplexing component which carries out wavelength multiplexing of the lightwave signal of each wavelength to the sending circuit T1 - T3 which transmit the lightwave signal of wavelength lambda1-lambda3, and is sent out to an optical transmission line 2. A receiving set 2 is constituted by the receiving circuits R1-R3 which receive the wavelength demultiplexing component which divides a wavelength multiplexing lightwave signal into the lightwave signal of wavelength lambda1-lambda3, and the lightwave signal of each wavelength.

[0005] With this configuration, sending-signal ** and ** are inputted into the wavelength multiplexing lightwave signal sending set 1-1 through a switcher 4, and it changes into the lightwave signal of wavelength lambda1 and lambda2, respectively, and transmits to the wavelength multiplexing lightwave signal receiving set 3-1 through wavelength many weights and an optical transmission line 2-1. In the wavelength multiplexing lightwave signal receiving set 3-1, a wavelength multiplexing lightwave signal is divided into the lightwave signal of wavelength lambda1 and lambda2, it receives, and input-signal ** and ** are outputted through a switcher 5. Here, when a failure occurs in the sending circuit T1 of the wavelength multiplexing lightwave signal sending set 1-1, a switcher 4 changes sending-signal ** to sending-circuit T3, and transmits it as a lightwave signal of wavelength lambda 3. On the other hand, in the wavelength multiplexing lightwave signal receiving set 3-1, the lightwave signal of wavelength lambda 3 is received in a receiving circuit R3, a switcher 5 is changed, and input-signal ** is outputted. In addition, it is also the same as when the failure occurred in the receiving circuit R1 of the wavelength multiplexing lightwave signal receiving set 3-1, or when a failure occurs in the lightwave signal of wavelength lambda 1 in an optical transmission line 2-1.

[0006] moreover, the same failure -- setting -- the wavelength multiplexing lightwave signal sending set 1-1, an optical transmission line 2-1, and the wavelength multiplexing lightwave signal receiving set 3-1 -- present -- business -- there is also the approach of changing from a system to the reserve system of the wavelength multiplexing lightwave signal sending set 1-2, an optical transmission line 2-2, and the wavelength multiplexing lightwave signal receiving set 3-2 extensively. In this case, also in failure generating of an optical transmission line 2-1, it can respond.

[0007]

[Problem(s) to be Solved by the Invention] By the way, the light wave length multiplex communication system of drawing 11 equips the duplex with the wavelength multiplexing lightwave signal sending set which has two or more sending circuits and wavelength multiplexing components, and the wavelength multiplexing lightwave signal receiving set which has two or more receiving circuits and wavelength demultiplexing components, respectively, in order to double an optical transmission line. Therefore, while cost became large, when the lightwave signal of a certain wavelength became a failure as mentioned above, there were two kinds of solutions, a wavelength change and the change of every sending set (receiving set), and there was high redundancy beyond the need.
[0008] This invention aims at offering the wavelength multiplexing lightwave signal sending set, wavelength multiplexing lightwave signal receiving set, and light wave length multiplex communication system which can respond to the both sides of the failure of the lightwave signal of each wavelength, and the failure of an optical transmission line by the configuration of the minimum and low cost.
[0009]
[Means for Solving the Problem] (Claims 1, 2, 5, 6, 8, and 10) The wavelength multiplexing lightwave signal sending set (claim 1) of this invention Two or more lightwave signal transmitting means to output the lightwave signal which put the sending signal on two or more light from which wavelength differs mutually non-become irregular, respectively, It has a wavelength multiplexing means to multiplex the lightwave signal of each wavelength outputted from two or more lightwave signal transmitting means, and to output a wavelength multiplexing lightwave signal, and an optical branching means to do n branching (for n to be two or more integers) of a wavelength multiplexing lightwave signal, and to transmit to juxtaposition in n optical transmission lines.
[0010] Moreover, the wavelength multiplexing lightwave signal sending set (claim 2) of this invention Two or more lightwave signal transmitting means to output the lightwave signal which put the sending signal on two or more light from which wavelength differs mutually non-become irregular, respectively, The lightwave signal of each wavelength of which n branching was done with two or more optical branching means which do n branching of the lightwave signal of each wavelength outputted from two or more lightwave signal transmitting means, respectively, and two or more optical branching means is multiplexed, respectively, n wavelength multiplexing lightwave signals are generated, and n optical transmission lines are equipped with n wavelength multiplexing means to transmit to juxtaposition.
[0011] On the other hand, the wavelength multiplexing lightwave signal receiving set (claim 5) of this invention A lightwave signal change means to choose one of the wavelength multiplexing lightwave signals transmitted to juxtaposition in n optical transmission lines, A wavelength demultiplexing means to separate spectrally into the lightwave signal of each wavelength the wavelength multiplexing lightwave signal chosen with the lightwave signal change means, Two or more lightwave signal receiving means to receive the lightwave signal of each wavelength, respectively and to output two or more input signals, When a failure is in the wavelength multiplexing lightwave signal transmitted through the optical transmission line chosen with the lightwave signal change means, or the lightwave signal of each wavelength, it has the control means which controls a lightwave signal change means to choose the wavelength multiplexing lightwave signal transmitted in other optical transmission lines.
[0012] Moreover, the wavelength multiplexing lightwave signal receiving set (claim 6) of this invention n wavelength demultiplexing means to separate spectrally into the lightwave signal of

each wavelength the wavelength multiplexing lightwave signal transmitted to juxtaposition in n optical transmission lines, respectively, A lightwave signal change means to choose one lightwave signal from the lightwave signal of each wavelength outputted from n wavelength demultiplexing means for every wavelength, The lightwave signal of each wavelength is received, respectively, and when a failure is in the lightwave signal of each wavelength chosen with two or more lightwave signal receiving means to output two or more input signals, and a lightwave signal change means, it has the control means which controls a lightwave signal change means to choose the lightwave signal transmitted in other optical transmission lines.
[0013] Furthermore, the light wave length multiplex communication system (claim 8) of this invention is the configuration of having connected between the above wavelength multiplexing lightwave signal sending set and wavelength multiplexing lightwave signal receiving sets through n optical transmission lines which carry out the parallel transmission of the wavelength multiplexing lightwave signal.
[0014] Thus, in the sending set side of this invention, by branching a wavelength multiplexing lightwave signal or a lightwave signal with an optical branching means by which passive elements, such as an optical coupler, were used, transmitting to juxtaposition in n optical transmission lines, choosing it with a lightwave signal change means in a receiving set side, and receiving, even if it does not use two or more wavelength multiplexing lightwave signal sending sets or wavelength multiplexing lightwave signal receiving sets, it can respond to the failure of an optical transmission line.
[0015] Moreover, failure restoration of a wavelength unit and failure restoration of an optical transmission line unit can be reconciled by having the signal change means which changes the lightwave signal which puts a sending signal on a wavelength multiplexing lightwave signal sending set, and having the signal change means which changes the input signal outputted to a wavelength multiplexing lightwave signal receiving set from a lightwave signal receiving means corresponding to the change of the signal change means of a wavelength multiplexing lightwave signal sending set (claim 10). That is, even when a failure occurs, for example during failure restoration of a wavelength unit in an optical transmission line, it can change to a spare optical transmission line, with the wavelength quota situation at the time maintained.
[0016] (Claims 3, 4, 7, 9, and 10) The wavelength multiplexing lightwave signal sending set (claim 3) of this invention The 1st lightwave signal transmitting means which outputs the lightwave signal which put the sending signal on a light of predetermined wavelength non-become irregular, The lightwave signal of the predetermined wavelength outputted from the 1st lightwave signal transmitting means n branching The optical branching means to carry out, The 2nd lightwave signal transmitting means which outputs n lightwave signals which put the sending signal on n light of the same wavelength non-become irregular mutually, respectively unlike predetermined wavelength, The lightwave signal of which n branching was done with the optical branching means, and n lightwave signals outputted from the 2nd lightwave signal transmitting means are multiplexed, respectively, n wavelength multiplexing lightwave signals are generated, and n optical transmission lines are equipped with n wavelength multiplexing means to transmit to juxtaposition. The 1st lightwave signal transmitting means is a configuration which outputs two or more lightwave signals with which wavelength differs mutually here, and the 2nd lightwave signal transmitting means is good also as a configuration which outputs the lightwave signal which is two or more sets from which n lightwave signals of the same wavelength are made into 1 set, and wavelength differs mutually (claim 4).

[0017] Moreover, the wavelength multiplexing lightwave signal receiving set (claim 7) of this invention n wavelength demultiplexing means to separate spectrally into the lightwave signal of each wavelength the wavelength multiplexing lightwave signal transmitted to juxtaposition in n optical transmission lines, respectively, Input the lightwave signal of each wavelength outputted from n wavelength demultiplexing means, and one lightwave signal is chosen for every wavelength about the wavelength of the 1st lightwave signal transmitting means. A lightwave signal change means to output the lightwave signal of each wavelength about the wavelength of the 2nd lightwave signal transmitting means, respectively, Two or more lightwave signal receiving means to receive the lightwave signal of each wavelength, respectively and to output two or more input signals, When a failure is in the lightwave signal of the wavelength of the 1st lightwave signal transmitting means chosen with the lightwave signal change means, it has the control means which controls a lightwave signal change means to choose the lightwave signal transmitted in other optical transmission lines.
[0018] Furthermore, the light wave length multiplex communication system (claim 9) of this invention is the configuration of having connected between the wavelength multiplexing lightwave signal sending set of claims 3 and 4, and the wavelength multiplexing lightwave signal receiving sets of claim 7 through n optical transmission lines which carry out the parallel transmission of the wavelength multiplexing lightwave signal. Moreover, it has the signal change means which changes the lightwave signal which puts a sending signal on a wavelength multiplexing lightwave signal sending set, and has the signal change means which changes the input signal outputted to a wavelength multiplexing lightwave signal receiving set from a lightwave signal receiving means corresponding to the change of the signal change means of a wavelength multiplexing lightwave signal sending set (claim 10).
[0019] Thus, since this invention can choose branching by the optical branching means (passive element), and the configuration which prepares two or more lightwave signal transmitting means for every wavelength, it can raise the use effectiveness of an optical transmission line. That is, although a signal usually different, respectively is transmitted on the wavelength which prepared two or more lightwave signal transmitting means, when a failure occurs, for example to the high signal of priority, it can change to the low path of priority.
[0020]
[Embodiment of the Invention] (1st operation gestalt) Drawing 1 shows the 1st operation gestalt of the light wave length multiplex communication system of this invention. This system is constituted by the wavelength multiplexing lightwave signal sending set 1, an optical transmission line 2-1 and 2-2, and the wavelength multiplexing lightwave signal receiving set 3 in drawing. Here, using wavelength lambda 0 as a control channel between transmitter-receivers, the sending signal of input port ** - ** shall be transmitted using wavelength lambda1-lambda4, and it shall output to output port ** - **.
[0021] The wavelength multiplexing lightwave signal sending set 1 is connected to the monitor section of the signal electronic switch 11 which connects the sending signal of input port ** - ** to a sending circuit 12 (henceforth "T1 - T four"), the sending circuit T1 which changes each sending signal into the lightwave signal of wavelength lambda1-lambda4 - T four, a sending circuit T1 - T four. Furthermore, it connects with the wavelength multiplexing lightwave signal receiving set 3 through the control channel of wavelength lambda 0. It is constituted by an optical transmission line 2-1 and the optical branching component 14 which transmits to 2-2 by dichotomizing the control circuit 15 which performs change control of the signal electronic

switch 11, the wavelength multiplexing component 13 which multiplexs the lightwave signal of each wavelength, and a wavelength multiplexing lightwave signal.

[0022] The wavelength multiplexing lightwave signal receiving set 3 An optical transmission line 2-1, the lightwave signal electronic switch 31 which carries out the selection output of one side of a wavelength multiplexing lightwave signal which receives from 2-2, the wavelength demultiplexing component 32 which separates a wavelength multiplexing lightwave signal spectrally into the lightwave signal of each wavelength, the receiving circuit 33 (henceforth "R1-R4") which receives the lightwave signal of wavelength lambda1-lambda4, It connects with the monitor section of the signal electronic switch 34 and receiving circuits R1-R4 which connects to output port ** - ** the input signal outputted from receiving circuits R1-R4. Furthermore, it connects with the wavelength multiplexing lightwave signal sending set 1 through the control channel of wavelength lambda 0, and is constituted by the control circuit 35 which performs change control of the lightwave signal electronic switch 31 and the signal electronic switch 34.

[0023] In addition, optical amplification repeating installation may be inserted in an optical transmission line 2-1 and 2-2 if needed. Moreover, what is necessary is to make it transmit to juxtaposition in three or more optical transmission lines, to replace with the optical branching component 14 of 2 input 2 output in that case, and just to use the optical branching component (optical star coupler) of a 1 input m output (m is three or more integers), although the configuration which doubled the optical transmission line here was shown.

[0024] Drawing 2 shows the example of control at the time of failure generating in the 1st operation gestalt. as failure generating and its detection gestalt -- (1) the case where a failure occurs on specific wavelength and it detects in the sending circuit 12 of the wavelength multiplexing lightwave signal sending set 1 -- (2) the case where a failure occurs on specific wavelength and it detects in the receiving circuit 33 of the wavelength multiplexing lightwave signal receiving set 3 -- (3) present -- business -- a failure occurs in the optical transmission line 2 of a system, and it may detect in the receiving circuit 33 of the wavelength multiplexing lightwave signal receiving set 3

[0025] first -- present -- business -- as a system, the sending signal of input port ** - ** shall be changed into the lightwave signal of wavelength lambda1-lambda3 by the sending circuit T1 - T3, it shall transmit through an optical transmission line 2-1, the lightwave signal of wavelength lambda1-lambda3 shall be received in receiving circuits R1-R3, and the condition of outputting each input signal to output port ** - ** shall be set up

[0026] (1) The monitor section of the failure generating sending circuit T1 of wavelength lambda 1 detects the failure of wavelength lambda 1, and notifies it to a control circuit 15 in a sending circuit T1. A control circuit 15 investigates the wavelength which is vacant now, controls the signal electronic switch 11, changes the sending signal of input port ** from a sending circuit T1 to sending-circuit T four, and transmits it as a lightwave signal of wavelength lambda 4. Moreover, a control circuit 15 notifies the change control information which shows that the sending signal of input port ** changed from wavelength lambda 1 to lambda 4 using the control channel of wavelength lambda 0 to the control circuit 35 of the wavelength multiplexing lightwave signal receiving set 3. A control circuit 35 controls the signal electronic switch 34 according to this change control information, changes connection with output port ** from a receiving circuit R1 to a receiving circuit R4, and receives the lightwave signal of wavelength lambda 4. A broken line shows the above change condition to the signal electronic switches 11 and 34 of drawing 1 .

[0027] (2) The monitor section of the failure generating receiving circuit R1 of wavelength lambda 1 detects the failure of wavelength lambda 1, and notifies it to a control circuit 35 in an optical transmission line 2-1 or a receiving circuit R1. A control circuit 35 investigates the wavelength which is vacant now, controls the signal electronic switch 34, changes connection with output port ** from a receiving circuit R1 to a receiving circuit R4, and receives the lightwave signal of wavelength lambda 4. Moreover, a control circuit 35 notifies the change control information which shows that the connection with output port ** changed from the receiving circuit R1 to the receiving circuit R4 using the control channel of wavelength lambda 0 to the control circuit 15 of the wavelength multiplexing lightwave signal sending set 1. A control circuit 15 controls the signal electronic switch 11 according to this change control information, changes the sending signal of input port ** from a sending circuit T1 to sending-circuit T four, and transmits it as a lightwave signal of wavelength lambda 4. A broken line shows the above change condition to the signal electronic switches 11 and 34 of drawing 1 .
[0028] (3) The monitor section of the failure generating receiving circuits R1-R3 detects the failure of wavelength lambda1-lambda3, respectively, and notifies it to a control circuit 35 in an optical transmission line 2-1. A control circuit 35 is judged to be the failure of an optical transmission line 2-1 from the failure of all wavelength, controls the lightwave signal electronic switch 31, and changes it from an optical transmission line 2-1 to connection with an optical transmission line 2-2. Thereby, the lightwave signal of the wavelength lambda1-lambda3 transmitted through the optical transmission line 2-2 is received in receiving circuits R1-R3. A broken line shows the above change condition to the lightwave signal electronic switch 31 of drawing 1 .
[0029] Thus, with 1 set of wavelength multiplexing lightwave signal sending sets 1, and the wavelength multiplexing lightwave signal receiving set 3, the light wave length multiplex transmission system of this operation gestalt can enable backup of an optical transmission line, and can respond also to backup of a wavelength unit further. In addition, although it was vacant and wavelength lambda 4 was secured as a channel with this operation gestalt, at the time, it uses for transmission of other signals, and when a failure occurs to the signal of wavelength lambda1-lambda3, other signals are stopped, and you may make it usually use them as backup of the signal of wavelength lambda1-lambda3.
[0030] (2nd operation gestalt) Drawing 3 shows the 2nd operation gestalt of the light wave length multiplex communication system of this invention. This system is constituted by the wavelength multiplexing lightwave signal sending set 1, an optical transmission line 2-1 and 2-2, and the wavelength multiplexing lightwave signal receiving set 3 in drawing. Here, using wavelength lambda 0 as a control channel between transmitter-receivers, the sending signal of input port ** - ** shall be transmitted using wavelength lambda1-lambda4, and it shall output to output port ** - **.
[0031] The wavelength multiplexing lightwave signal sending set 1 The sending signal of input port ** The sending signal of the sending circuit T1 changed into the lightwave signal of wavelength lambda 1, the sending circuit T2 which changes the sending signal of input port ** into the lightwave signal of wavelength lambda 2, the sending circuits T31 and T32 which change the sending signal of input port ** into the lightwave signal of wavelength lambda 3, and input port ** Drive control of one side is carried out. the sending circuits T41 and T42 and sending circuit T31 which are changed into the lightwave signal of wavelength lambda 4, and each of T32, T41, and T42 -- The control circuit 15 connected to the wavelength multiplexing lightwave signal receiving set 3 through the control channel of wavelength lambda 0, the optical

branching component 14 which dichotomizes the lightwave signal of each wavelength, respectively, and the lightwave signal of each dichotomous wavelength are multiplexed, respectively. It is constituted by an optical transmission line 2-1, the wavelength multiplexing component 13-1 transmitted to 2-2, and 13-2.
[0032] The wavelength multiplexing lightwave signal receiving set 3 The lightwave signal of an optical transmission line 2-1, the wavelength demultiplexing component 32-1 which separates spectrally into the lightwave signal of each wavelength the wavelength multiplexing lightwave signal received from 2-2, respectively, 32-2, the lightwave signal electronic switch 31 which connects the lightwave signal of each wavelength to receiving circuits R1-R4 and a control circuit 35, and wavelength lambda1-lambda4 is received. It connects with the monitor section of receiving circuits R1-R4 and receiving circuits R1-R4 outputted to output port ** - **, connects with the wavelength multiplexing lightwave signal sending set 1 through the control channel of wavelength lambda 0 further, and is constituted by the control circuit 35 which performs change control of the lightwave signal electronic switch 31.
[0033] In addition, optical amplification repeating installation may be inserted in an optical transmission line 2-1 and 2-2 if needed. Moreover, although the configuration which doubled the optical transmission line here was shown, it may be made to transmit to juxtaposition in three or more optical transmission lines, and it replaces with the optical branching component 14 of 2 input 2 output in that case, and the wavelength multiplexing component 13-1 corresponding to each optical transmission line - 13-n are used using the optical branching component (optical star coupler) of a 1 input m output (m is three or more integers). Moreover, the wavelength multiplexing lightwave signal receiving set 3 of this operation gestalt may be replaced with the thing of the configuration except the signal switcher 34 from the wavelength multiplexing lightwave signal receiving set 3 of the 1st operation gestalt.
[0034] The sending circuits T31 and T32 of wavelength lambda 3 and the sending circuits T41 and T42 of wavelength lambda 4 double, respectively, one of these usually operates, and a control circuit 15 controls this operation gestalt to change to actuation of another side at the time of the failure. The lightwave signal of the wavelength lambda3 and lambda4 outputted from the either branches to the wavelength multiplexing component 13-1 and 13-2 through the optical branching component 14 of 2 input 2 output, and is transmitted to juxtaposition an optical transmission line 2-1 and 2-2.
[0035] On the other hand, when a failure occurs in an optical transmission line 2-1 and it detects in receiving circuits R1-R4, a control circuit 35 is changed to connection with the lightwave signal of each wavelength which controlled the lightwave signal electronic switch 31 and was separated with the wavelength demultiplexing component 32-2. Thereby, the lightwave signal of the wavelength lambda1-lambda4 transmitted through the optical transmission line 2-2 is received in receiving circuits R1-R4.
[0036] Thus, with 1 set of wavelength multiplexing lightwave signal sending sets 1, and the wavelength multiplexing lightwave signal receiving set 3, the light wave length multiplex transmission system of this operation gestalt can enable backup of an optical transmission line, and can respond also to backup of the sending circuit of a part of [further] wavelength.
[0037] (3rd operation gestalt) Drawing 4 shows the 3rd operation gestalt of the light wave length multiplex communication system of this invention. This system is constituted by the wavelength multiplexing lightwave signal sending set 1, an optical transmission line 2-1 and 2-2, and the wavelength multiplexing lightwave signal receiving set 3 in drawing. Here, using wavelength lambda 0 as a control channel between transmitter-receivers, the sending signal of input port ** -

** shall be transmitted using wavelength lambda1-lambda4, and it shall output to output port ** - **. Moreover, by dichotomizing and transmitting about the sending signal of input port ** and **, it has the redundancy in an optical transmission line, and the redundancy between an optical transmission line and a signal is secured by signal change about the sending signal of input port ** - **. Moreover, optical amplification repeating installation may be inserted in an optical transmission line 2-1 and 2-2 if needed.

[0038] The wavelength multiplexing lightwave signal sending set 1 The sending signal of input port ** - ** The lightwave signal of the signal electronic switch 11 linked to sending-circuit T3-T6, the sending circuit T1 which changes the sending signal of input port ** into the lightwave signal of wavelength lambda 1, the sending circuit T2 which changes the sending signal of input port ** into the lightwave signal of wavelength lambda 2, sending-circuit T3 which outputs the lightwave signal of wavelength lambda 3, T5, and wavelength lambda 4 It connects with the monitor section of sending-circuit T four to output, T6, and sending-circuit T3-T6. Furthermore, it connects with the wavelength multiplexing lightwave signal receiving set 3 through the control channel of wavelength lambda 0. The control circuit 15 which performs change control of the signal electronic switch 11, the optical branching component 14 which dichotomizes the lightwave signal of wavelength lambda0-lambda2, respectively, and the lightwave signal of the wavelength lambda3 and lambda4 which while dichotomized and is outputted from the lightwave signal of wavelength lambda0-lambda2 and sending-circuit T3, and T four are multiplexed. It is constituted by the wavelength multiplexing component 13-2 which multiplexs the lightwave signal of the wavelength lambda3 and lambda4 outputted from the lightwave signal and sending circuits T5 and T6 of wavelength lambda0-lambda2 of the wavelength multiplexing component 13-1 transmitted to an optical transmission line 2-1, and dichotomous another side, and is transmitted to an optical transmission line 2-2.

[0039] Here, sending circuits T1 and T2 (lambda1, lambda2) correspond to the 1st lightwave signal transmitting means in claims 3 and 4, and sending-circuit T3-T6 (lambda3, lambda4) corresponds to the 2nd lightwave signal transmitting means in claims 3 and 4, and, in the case of n= 2, they correspond. In addition, the wavelength of the 1st lightwave signal transmitting means and the 2nd lightwave signal transmitting means may be one or three or more, respectively.

[0040] The wavelength multiplexing lightwave signal receiving set 3 The lightwave signal of an optical transmission line 2-1, the wavelength demultiplexing component 32-1 which separates spectrally into the lightwave signal of each wavelength the wavelength multiplexing lightwave signal received from 2-2, respectively, 32-2, the lightwave signal electronic switch 31 which connects the lightwave signal of each wavelength to receiving circuits R1-R6 and a control circuit 35, and wavelength lambda1 and lambda2 is received. The receiving circuits R1 and R2 outputted to output port ** and **, the receiving circuits R3 and R5 which receive the lightwave signal of wavelength lambda 3, the receiving circuits R4 and R6 which receive the lightwave signal of wavelength lambda 4, the signal electronic switch 34 which connects to output port ** - ** the input signal outputted from receiving circuits R3-R6, It connects with the monitor section of receiving circuits R1-R6, connects with the wavelength multiplexing lightwave signal sending set 1 through the control channel of wavelength lambda 0 further, and is constituted by the control circuit 35 which performs change control of the lightwave signal electronic switch 31 and the signal electronic switch 34.

[0041] With this configuration, the sending signal of input port ** - ** is transmitted through an optical transmission line 2-1 as a lightwave signal of wavelength lambda1-lambda4, respectively, and is outputted to output port ** - **. Moreover, the sending signal of input port ** and ** is

transmitted through an optical transmission line 2-2 as a lightwave signal of wavelength lambda3 and lambda4, respectively, and is outputted to output port ** and **. At this time, the sending signal of input port ** and ** is transmitted to juxtaposition in an optical transmission line 2-1 and 2-2 as a lightwave signal of wavelength lambda1 and lambda2, chooses an optical transmission line 2-1 and either of 2-2 by the change of the lightwave signal electronic switch 31, and is receivable to receiving circuits R1 and R2. That is, about the sending signal of input port ** and **, when a failure occurs in an optical transmission line 2-1, as a broken line shows to drawing 4 , backup is possible by the change of the lightwave signal electronic switch 31. Moreover, when a failure occurs in the lightwave signal of wavelength lambda1 and lambda2 with the optical amplification repeating installation of an optical transmission line 2-1 etc., it can restore by bypassing to an optical transmission line 2-2 similarly. However, since there is no backup in sending circuits T1 and T2 and receiving circuits R1 and R2, the failure restoration cannot be performed.

[0042] On the other hand, this configuration has not prepared backup of an optical transmission line about the sending signal of input port ** - **. However, backup of an optical transmission line or each lightwave signal is attained by preparing priority in each signal, stopping transmission of the low signal of priority at the time of failure generating, and transmitting the high signal of priority using the transceiver circuit. Hereafter, the example of control at the time of this failure generating is explained with reference to drawing 5 -7.

[0043] (1) When a failure occurs in an optical transmission line 2-1, drawing 5 shows the example of restoration of the sending signal of input port ** - **, when a failure occurs in an optical transmission line 2-1. About the sending signal and control channel of input port ** and **, the backup which uses an optical transmission line 2-2 is attained by the change of the lightwave signal electronic switch 31 as mentioned above.

[0044] Here, the priority of the sending signal of input port ** and ** presupposes that it is higher than the priority of the sending signal of input port ** and **. According to the failure of an optical transmission line 2-1, sending-circuit T3 and T four which change the sending signal of input port ** and ** into a lightwave signal cannot be used. Then, a control circuit 15 controls the signal electronic switch 11, and connects the sending signal of input port ** and ** to sending circuits T5 and T6 instead of the sending signal of input port ** and **. Thereby, the sending signal of input port ** - ** is transmitted to the wavelength multiplexing lightwave signal receiving set 3 through an optical transmission line 2-2 as a lightwave signal of wavelength lambda1-lambda4. The change control information of the signal electronic switch 11 is notified to the control circuit 35 of the wavelength multiplexing lightwave signal receiving set 3 from a control circuit 15.

[0045] In the wavelength multiplexing lightwave signal receiving set 3, each input signal is outputted to output port ** - ** by a control circuit's 35 controlling the lightwave signal electronic switch 31, and connecting to receiving circuits R1-R4 the lightwave signal of the wavelength lambda1-lambda4 separated spectrally with the wavelength demultiplexing component 32-2. In addition, as a drawing destructive line shows, it receives in receiving circuits R5 and R6, and you may make it connect with output port ** and ** by the change of the signal electronic switch 34 about the lightwave signal of wavelength lambda3 and lambda4.

[0046] (2) When a failure occurs in sending-circuit T3, drawing 6 shows the example of restoration of the sending signal of input port **, when a failure occurs in sending-circuit T3. Here, the priority of the sending signal of input port ** and ** presupposes that it is higher than the priority of the sending signal of input port ** and **.

[0047] The monitor section of sending-circuit T3 detects the failure of wavelength lambda 3, and notifies it to a control circuit 15. A control circuit 15 controls the signal electronic switch 11, from the sending signal of input port **, it stops connection of the sending signal of low input port ** of priority, changes the sending signal of input port ** from sending-circuit T3 to a sending circuit T5, and transmits it through an optical transmission line 2-2. Moreover, a control circuit 15 notifies the change control information which shows that the sending signal of input port ** changed to the optical transmission line 2-2 using the control channel of wavelength lambda 0 to the control circuit 35 of the wavelength multiplexing lightwave signal receiving set 3. A control circuit 35 controls the lightwave signal electronic switch 31 according to this change control information, changes the lightwave signal of wavelength lambda 3 from a receiving circuit R5 to a receiving circuit R3, and is made to receive it. Thereby, the sending signal of input port ** is outputted to output port **. In addition, as a drawing destructive line shows, it receives in a receiving circuit R5, and you may make it connect with output port ** by the change of the signal electronic switch 34 about the lightwave signal of wavelength lambda 3.
[0048] (3) When a failure occurs in a receiving circuit R3, drawing 7 shows the example of restoration of the sending signal of input port **, when a failure occurs in a receiving circuit R3. Here, the priority of the transceiver signal of input/output port ** and ** presupposes that it is higher than the priority of the transceiver signal of input/output port ** and **.
[0049] The monitor section of a receiving circuit R3 detects the failure of wavelength lambda 3, and notifies it to a control circuit 35. A control circuit 35 controls the lightwave signal electronic switch 31 and the signal electronic switch 34, and from the input signal of output port **, connection of the input signal of low output port ** of priority is stopped, and the lightwave signal of wavelength lambda 3 is changed from a receiving circuit R3 to a receiving circuit R5, it receives, and it outputs them to output port **. Thereby, the sending signal of input port ** is outputted to output port **.
[0050] (4) When a failure occurs on wavelength lambda 3 and it detects in a receiving circuit R3, a failure generates drawing 8 on wavelength lambda 3, and when it detects in a receiving circuit R3, the example of restoration of the sending signal of input port ** is shown. Here, the priority of the transceiver signal of input/output port ** and ** presupposes that it is higher than the priority of the transceiver signal of input/output port ** and **.
[0051] The monitor section of a receiving circuit R3 detects the failure of the wavelength lambda 3 by the optical amplification repeater of an optical transmission line 2-1 etc., and notifies it to a control circuit 35. A control circuit 35 controls the signal electronic switch 34, from the input signal of output port **, stops connection of the input signal of low output port ** of priority, and changes connection with output port ** from a receiving circuit R3 to a receiving circuit R5. Moreover, a control circuit 35 notifies the change control information which shows that the connection with output port ** changed from the receiving circuit R3 to the receiving circuit R5 using the control channel of wavelength lambda 0 to the control circuit 15 of the wavelength multiplexing lightwave signal sending set 1. A control circuit 15 controls the signal electronic switch 11 according to this change control information, changes the sending signal of input port ** from sending-circuit T3 to a sending circuit T5, and transmits it as a lightwave signal of wavelength lambda 3. Thereby, the sending signal of input port ** is outputted to output port **. In addition, as a drawing destructive line shows, the change of the lightwave signal electronic switch 31 receives in a receiving circuit R3, and you may make it connect with output port ** about the lightwave signal of wavelength lambda 3.

[0052] (4th operation gestalt) The operation gestalt explained above has the composition that opposite arrangement of the wavelength multiplexing lightwave signal sending set 1 and the wavelength multiplexing lightwave signal receiving set 3 is carried out through an optical transmission line 2-1 and 2-2. Namely, drawing 9 (1) It has the shown adjoining node 6-1 and composition which doubled the optical transmission line among 6-3. Here, it is drawing 9 (2). The path which minds an optical transmission line 2-2, a node 6-2, and an optical transmission line 2-3 as backup of an optical transmission line 2-1 can be set up by inserting the node 6-2 which contains the wavelength multiplexing lightwave signal receiving set 3 and the wavelength multiplexing lightwave signal sending set 1 in the path of an optical transmission line 2-2 so that it may be shown.
[0053] Thus, in a general network, by using the wavelength multiplexing lightwave signal sending set 1 and the wavelength multiplexing lightwave signal receiving set 3 of each operation gestalt which were mentioned above as the sending set which constitutes a node, and a receiving set, when a failure occurs in the lightwave signal of a certain wavelength in a wavelength multiplexing lightwave signal, it changes to reserve wavelength, and when a failure occurs in an optical transmission line, the configuration changed to a reserve optical transmission line can be realized.
[0054] In addition, in the path of the multi-hop through other nodes, the band used in each path will be shared, and since a limit joins the band which can use each, it is necessary to correspond to a band limit using a buffer etc. Moreover, in order to choose a path in consideration of band fluctuation, decision by the high order layer is suitable. Then, when the operation system which employs a communication link grasps a signal path, and notifies the modification information to the equipment of a high order layer and a high order layer determines the optimal path, efficient communication system is realizable. Besides, it is IP (Internet Protocol) as a layer. When using it, the router which determines a communication path has grasped the toll of a transmission line, the confusion situation, etc., and has determined the path of each commo data. Therefore, an efficient communication link is realizable by changing the parameter of the path between each router and choosing the optimal path by the notice from operation system.
[0055]
[Effect of the Invention] As explained above, the wavelength multiplexing lightwave signal sending set of this invention, a wavelength multiplexing lightwave signal receiving set, and a light wave length multiplex communication system are changed to reserve wavelength, when a failure occurs in the lightwave signal of a certain wavelength in a wavelength multiplexing lightwave signal, and when a failure occurs in an optical transmission line, the configuration changed to a reserve optical transmission line can be realized by low cost.

[Translation done.]

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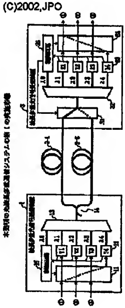
(54) **WAVELENGTH-MULTIPLEXED OPTICAL SIGNAL TRANSMITTING DEVICE, WAVELENGTH-MULTIPLEXED OPTICAL SIGNAL RECEIVING DEVICE AND OPTICAL WAVELENGTH-MULTIPLEXED COMMUNICATION SYSTEM**

(57) Abstract:

PROBLEM TO BE SOLVED: To deal with both the faults of optical signals of respective wavelengths and a fault on an optical transmission line in minimum low-cost configuration.

SOLUTION: A wavelength-multiplexed optical signal transmitting device 1 is provided with plural optical signal transmitting means 12 for outputting the plural optical signals of mutually different wavelengths, on which transmitting signals are respectively loaded, a wavelength multiplexing means 13 for outputting a wavelength-multiplexed optical signal by multiplexing the optical signals of respective wavelengths and an optical demultiplexing means 14 for demultiplexing the wavelength-multiplexed optical signal to (n) and parallel transmitting them to (n) optical transmission lines. A wavelength-multiplexed optical signal receiving device 3 is provided with an optical signal switching means 34 for selecting one of wavelength-multiplexed optical signals parallel transmitted on (n) optical transmission lines, wavelength demultiplexing means 32 for demultiplexing the wavelength-multiplexed optical signal to the optical signals of respective wavelengths, plural optical signal receiving means 33 for respectively receiving the optical signals of respective wavelengths, and control means 35 for controlling the optical signal switching means to select the wavelength-multiplexed optical signal transmitted on the other optical transmission line when there is a fault on the wavelength-multiplexed optical signal or optical signals of respective wavelengths.



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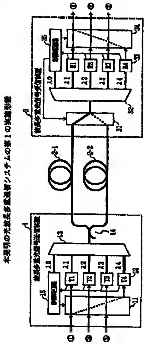
(54)【発明の名称】　波長多重光信号送信装置、波長多重光信号受信装置および光波長多重通信システム

(57)【要約】　　（修正有）
【課題】　最小限および低コストの構成により、各波長の光信号の障害と、光伝送路の障害の双方に対応する。
【解決手段】　波長多重光信号送信装置１は、それぞれ送信信号をのせた互いに波長が異なる複数の光信号を出力する複数の光信号送信手段１２と、各波長の光信号を合波して波長多重光信号を出力する波長多重手段１３と、波長多重光信号をｎ分岐し、ｎ本の光伝送路に並列に送信する光分岐手段１４とを備える。波長多重光信号受信装置３は、ｎ本の光伝送路で並列に伝送された波長多重光信号の１つを選択する光信号切替手段３４と、波長多重光信号を各波長の光信号に分波する波長多重分離手段３２と、各波長の光信号をそれぞれ受信する複数の光信号受信手段３３と、波長多重光信号または各波長の光信号に障害がある場合に、他の光伝送路を伝送された波長多重光信号を選択するように光信号切替手段を制御する制御手段３５とを備える。



【特許請求の範囲】

【請求項１】　互いに波長が異なる複数の無変調光にそれぞれ送信信号をのせた光信号を出力する複数の光信号送信手段と、
前記複数の光信号送信手段から出力される各波長の光信号を合波して波長多重光信号を出力する波長多重手段と、
前記波長多重光信号をｎ分岐（ｎは２以上の整数）し、ｎ本の光伝送路に並列に送信する光分岐手段とを備えたことを特徴とする波長多重光信号送信装置。

【請求項２】　互いに波長が異なる複数の無変調光にそれぞれ送信信号をのせた光信号を出力する複数の光信号送信手段と、
前記複数の光信号送信手段から出力される各波長の光信号をそれぞれｎ分岐する複数の光分岐手段と、
前記複数の光分岐手段でｎ分岐された各波長の光信号をそれぞれ合波してｎ個の波長多重光信号を生成し、ｎ本の光伝送路に並列に送信するｎ個の波長多重手段とを備えたことを特徴とする波長多重光信号送信装置。

【請求項３】　所定の波長の無変調光に送信信号をのせた光信号を出力する第１の光信号送信手段と、
前記第１の光信号送信手段から出力される所定の波長の光信号をｎ分岐する光分岐手段と、
前記所定の波長と異なり、互いに同一波長のｎ個の無変調光にそれぞれ送信信号をのせたｎ個の光信号を出力する第２の光信号送信手段と、
前記光分岐手段でｎ分岐された光信号と、前記第２の光信号送信手段から出力されるｎ個の光信号をそれぞれ合波してｎ個の波長多重光信号を生成し、ｎ本の光伝送路に並列に送信するｎ個の波長多重手段とを備えたことを特徴とする波長多重光信号送信装置。

【請求項４】　請求項３に記載の波長多重光信号送信装置において、
前記第１の光信号送信手段は、互いに波長が異なる複数の光信号を出力する構成であり、
前記第２の光信号送信手段は、同一波長のｎ個の光信号を１組とし、互いに波長が異なる複数組の光信号を出力する構成であることを特徴とする波長多重光信号送信装置。

【請求項５】　ｎ本の光伝送路で並列に伝送された波長多重光信号の１つを選択する光信号切替手段と、
前記光信号切替手段で選択された波長多重光信号を各波長の光信号に分波する波長多重分離手段と、
前記各波長の光信号をそれぞれ受信し、複数の受信信号を出力する複数の光信号受信手段と、
前記光信号切替手段で選択された光伝送路を介して伝送された波長多重光信号または各波長の光信号に障害がある場合に、他の光伝送路を伝送された波長多重光信号を選択するように前記光信号切替手段を制御する制御手段とを備えたことを特徴とする波長多重光信号受信装置。

【請求項６】　ｎ本の光伝送路で並列に伝送された波長多重光信号をそれぞれ各波長の光信号に分波するｎ個の波長多重分離手段と、
前記ｎ個の波長多重分離手段から出力される各波長の光信号から各波長ごとに１つの光信号を選択する光信号切替手段と、
前記各波長の光信号をそれぞれ受信し、複数の受信信号を出力する複数の光信号受信手段と、
前記光信号切替手段で選択された各波長の光信号に障害がある場合に、他の光伝送路を伝送された光信号を選択するように前記光信号切替手段を制御する制御手段とを備えたことを特徴とする波長多重光信号受信装置。

【請求項７】　ｎ本の光伝送路で並列に伝送された波長多重光信号をそれぞれ各波長の光信号に分波するｎ個の波長多重分離手段と、
前記ｎ個の波長多重分離手段から出力される各波長の光信号を入力し、請求項３に記載の第１の光信号送信手段の波長については各波長ごとに１つの光信号を選択し、請求項３に記載の第２の光信号送信手段の波長については各波長の光信号をそれぞれ出力する光信号切替手段と、
前記各波長の光信号をそれぞれ受信し、複数の受信信号を出力する複数の光信号受信手段と、
前記光信号切替手段で選択された前記第１の光信号送信手段の波長の光信号に障害がある場合に、他の光伝送路を伝送された光信号を選択するように前記光信号切替手段を制御する制御手段とを備えたことを特徴とする波長多重光信号受信装置。

【請求項８】　請求項１または請求項２に記載の波長多重光信号送信装置と、請求項５または請求項６に記載の波長多重光信号受信装置との間を波長多重光信号を並列伝送するｎ本の光伝送路を介して接続した構成であることを特徴とする光波長多重通信システム。

【請求項９】　請求項３または請求項４に記載の波長多重光信号送信装置と、請求項７に記載の波長多重光信号受信装置との間を波長多重光信号を並列伝送するｎ本の光伝送路を介して接続した構成であることを特徴とする光波長多重通信システム。

【請求項１０】　請求項８または請求項９に記載の光波長多重通信システムにおいて、
前記波長多重光信号送信装置に、前記送信信号をのせる光信号を切り替える信号切替手段を備え、
前記波長多重光信号受信装置に、前記波長多重光信号送信装置の信号切替手段の切り替えに対応して前記光信号受信手段から出力される受信信号を切り替える信号切替手段を備えたことを特徴とする光波長多重通信システム。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、光波長多重伝送さ

れる光信号のうちある波長の光信号に障害が発生した場合には予備波長に切り替え、光伝送路に障害が発生した場合には予備光伝送路に切り替えて障害復旧を行う波長多重光信号送信装置、波長多重光信号受信装置および光波長多重通信システムに関する。

【０００２】

【従来の技術】高い信頼性が要求される光通信システムでは、図１０に示すように、光信号送信装置１０、光伝送路２、光信号受信装置３０を複数組備え、送信装置側の切替器４と受信装置側の切替器５を用いて切り替える構成になっている。すなわち、通常は光信号送信装置１０－１、光伝送路２－１、光信号受信装置３０－１を現用系として用いて送受信を行い、そのいずれかに障害が発生した場合には図示しない制御系を用いて切替器４，５を制御し、予備系を構成する光信号送信装置１０－２、光伝送路２－２、光信号受信装置３０－２に切り替えるようになっている。

【０００３】また、光波長多重通信システムでは、複数の波長で異なる信号を伝送することができるので、１本の光伝送路に複数の通信路を形成することができる。したがって、ある波長の送信回路または受信回路が故障した場合には、他の波長の送信回路および受信回路に切り替えるだけで、同じ光伝送路を用いて通信を継続することができる。しかし、光伝送路の故障に対しては、図１０の場合と同様に光伝送路を二重に備える必要がある。

【０００４】図１１は、高い信頼性が要求される光波長多重通信システムの構成例を示す。図において、波長多重光信号送信装置１－１、光伝送路２－１、波長多重光信号受信装置３－１は現用系を構成し、波長多重光信号送信装置１－２、光伝送路２－２、波長多重光信号受信装置３－２は予備系を構成する。波長多重光信号送信装置１は、波長λ１～λ３の光信号を送信する送信回路Ｔ１～Ｔ３と、各波長の光信号を波長多重して光伝送路２に送出する波長多重素子により構成される。受信装置２は、波長多重光信号を波長λ１～λ３の光信号に分離する波長多重分離素子と、各波長の光信号を受信する受信回路Ｒ１～Ｒ３により構成される。

【０００５】本構成では、送信信号①，②を切替器４を介して波長多重光信号送信装置１－１に入力し、それぞれ波長λ１，λ２の光信号に変換して波長多重し、光伝送路２－１を介して波長多重光信号受信装置３－１に伝送する。波長多重光信号受信装置３－１では、波長多重光信号を波長λ１，λ２の光信号に分離して受信し、受信信号①，②を切替器５を介して出力する。　ここで、例えば波長多重光信号送信装置１－１の送信回路Ｔ１に障害が発生した場合に、切替器４は送信信号①を送信回路Ｔ３に切り替え、波長λ３の光信号として伝送する。一方、波長多重光信号受信装置３－１では受信回路Ｒ３で波長λ３の光信号を受信し、切替器５を切り替えて受信信号①を出力する。なお、波長多重光信号受信装置３－１の受信回路Ｒ１に障害が発生した場合や、光伝送路２－１で波長λ１の光信号に障害が発生した場合も同様である。

【０００６】また、同様の故障において、波長多重光信号送信装置１－１、光伝送路２－１、波長多重光信号受信装置３－１の現用系から、波長多重光信号送信装置１－２、光伝送路２－２、波長多重光信号受信装置３－２の予備系に全面的に切り替える方法もある。この場合には、光伝送路２－１の障害発生の場合にも対応できる。

【０００７】

【発明が解決しようとする課題】ところで、図１１の光波長多重通信システムは、光伝送路を二重化するために、複数の送信回路および波長多重素子を有する波長多重光信号送信装置と、複数の受信回路および波長多重分離素子を有する波長多重光信号受信装置をそれぞれ二重に備えている。そのため、コストが大きくなるとともに、上記のようにある波長の光信号が障害となったときに、波長切替えと送信装置（受信装置）ごとの切替えの２通りの対処方法があり、必要以上の高い冗長性があった。

【０００８】本発明は、最小限および低コストの構成により、各波長の光信号の障害と、光伝送路の障害の双方に対応することができる波長多重光信号送信装置、波長多重光信号受信装置および光波長多重通信システムを提供することを目的とする。

【０００９】

【課題を解決するための手段】（請求項１，２，５，６，８，１０）本発明の波長多重光信号送信装置（請求項１）は、互いに波長が異なる複数の無変調光にそれぞれ送信信号をのせた光信号を出力する複数の光信号送信手段と、複数の光信号送信手段から出力される各波長の光信号を合波して波長多重光信号を出力する波長多重手段と、波長多重光信号をｎ分岐（ｎは２以上の整数）し、ｎ本の光伝送路に並列に送信する光分岐手段とを備える。

【００１０】また、本発明の波長多重光信号送信装置（請求項２）は、互いに波長が異なる複数の無変調光にそれぞれ送信信号をのせた光信号を出力する複数の光信号送信手段と、複数の光信号送信手段から出力される各波長の光信号をそれぞれｎ分岐する複数の光分岐手段と、複数の光分岐手段でｎ分岐された各波長の光信号をそれぞれ合波してｎ個の波長多重光信号を生成し、ｎ本の光伝送路に並列に送信するｎ個の波長多重手段とを備える。

【００１１】一方、本発明の波長多重光信号受信装置（請求項５）は、ｎ本の光伝送路で並列に伝送された波長多重光信号の１つを選択する光信号切替手段と、光信号切替手段で選択された波長多重光信号を各波長の光信号に分波する波長多重分離手段と、各波長の光信号をそれぞれ受信し、複数の受信信号を出力する複数の光信号

受信手段と、光信号切替手段で選択された光伝送路を介して伝送された波長多重光信号または各波長の光信号に障害がある場合に、他の光伝送路を伝送された波長多重光信号を選択するように光信号切替手段を制御する制御手段とを備える。

【００１２】また、本発明の波長多重光信号受信装置（請求項６）は、ｎ本の光伝送路で並列に伝送された波長多重光信号をそれぞれ各波長の光信号に分波するｎ個の波長多重分離手段と、ｎ個の波長多重分離手段から出力される各波長の光信号から各波長ごとに１つの光信号を選択する光信号切替手段と、各波長の光信号をそれぞれ受信し、複数の受信信号を出力する複数の光信号受信手段と、光信号切替手段で選択された各波長の光信号に障害がある場合に、他の光伝送路を伝送された光信号を選択するように光信号切替手段を制御する制御手段とを備える。

【００１３】さらに、本発明の光波長多重通信システム（請求項８）は、以上の波長多重光信号送信装置と波長多重光信号受信装置との間を波長多重光信号を並列伝送するｎ本の光伝送路を介して接続した構成である。

【００１４】このように、本発明の送信装置側では、光カプラ等の受動素子を用いた光分岐手段で波長多重光信号または光信号を分岐してｎ本の光伝送路に並列に送信し、受信装置側ではそれを光信号切替手段で選択して受信することにより、複数の波長多重光信号送信装置や波長多重光信号受信装置を用いなくても光伝送路の障害に対応することができる。

【００１５】また、波長多重光信号送信装置に、送信信号をのせる光信号を切り替える信号切替手段を備え、波長多重光信号受信装置に、波長多重光信号送信装置の信号切替手段の切り替えに対応して光信号受信手段から出力される受信信号を切り替える信号切替手段を備えることにより、波長単位の障害復旧と光伝送路単位の障害復旧を両立させることができる（請求項１０）。すなわち、例えば波長単位の障害復旧中に光伝送路に障害が発生した場合でも、その時点の波長割り当て状況を維持したまま予備の光伝送路に切り替えることができる。

【００１６】（請求項３，４，７，９，１０）本発明の波長多重光信号送信装置（請求項３）は、所定の波長の無変調光に送信信号をのせた光信号を出力する第１の光信号送信手段と、第１の光信号送信手段から出力される所定の波長の光信号をｎ分岐する光分岐手段と、所定の波長と異なり、互いに同一波長のｎ個の無変調光にそれぞれ送信信号をのせたｎ個の光信号を出力する第２の光信号送信手段と、光分岐手段でｎ分岐された光信号と、第２の光信号送信手段から出力されるｎ個の光信号をそれぞれ合波してｎ個の波長多重光信号を生成し、ｎ本の光伝送路に並列に送信するｎ個の波長多重手段とを備える。ここで、第１の光信号送信手段は、互いに波長が異なる複数の光信号を出力する構成であり、第２の光信号送信手段は、同一波長のｎ個の光信号を１組とし、互いに波長が異なる複数組の光信号を出力する構成としてもよい（請求項４）。

【００１７】また、本発明の波長多重光信号受信装置（請求項７）は、ｎ本の光伝送路で並列に伝送された波長多重光信号をそれぞれ各波長の光信号に分波するｎ個の波長多重分離手段と、ｎ個の波長多重分離手段から出力される各波長の光信号を入力し、第１の光信号送信手段の波長については各波長ごとに１つの光信号を選択し、第２の光信号送信手段の波長については各波長の光信号をそれぞれ出力する光信号切替手段と、各波長の光信号をそれぞれ受信し、複数の受信信号を出力する複数の光信号受信手段と、光信号切替手段で選択された第１の光信号送信手段の波長の光信号に障害がある場合に、他の光伝送路を伝送された光信号を選択するように光信号切替手段を制御する制御手段とを備える。

【００１８】さらに、本発明の光波長多重通信システム（請求項９）は、請求項３，４の波長多重光信号送信装置と請求項７の波長多重光信号受信装置との間を波長多重光信号を並列伝送するｎ本の光伝送路を介して接続した構成である。また、波長多重光信号送信装置に、送信信号をのせる光信号を切り替える信号切替手段を備え、波長多重光信号受信装置に、波長多重光信号送信装置の信号切替手段の切り替えに対応して光信号受信手段から出力される受信信号を切り替える信号切替手段を備える（請求項１０）。

【００１９】このように、本発明は、各波長ごとに光分岐手段（受動素子）による分岐と、光信号送信手段を複数用意する構成を選択できるので、光伝送路の利用効率を高めることができる。すなわち、光信号送信手段を複数用意した波長では、通常はそれぞれ異なる信号を伝送しているが、例えば優先順位の高い信号に障害が発生した場合には、優先順位の低い経路に切り替えることができる。

【００２０】

【発明の実施の形態】（第１の実施形態）図１は、本発明の光波長多重通信システムの第１の実施形態を示す。図において、本システムは、波長多重光信号送信装置１と、光伝送路２－１，２－２と、波長多重光信号受信装置３により構成される。ここでは、送受信装置間の制御チャネルとして波長λ０を用い、入力ポート①～③の送信信号を波長λ１～λ４を用いて伝送し、出力ポート①～③に出力するものとする。

【００２１】波長多重光信号送信装置１は、入力ポート①～③の送信信号を送信回路１２（以下「Ｔ１～Ｔ４」という）に接続する信号切替回路１１、各送信信号を波長λ１～λ４の光信号に変換する送信回路Ｔ１～Ｔ４、送信回路Ｔ１～Ｔ４のモニタ部に接続され、さらに波長λ０の制御チャネルを介して波長多重光信号受信装置３に接続され、信号切替回路１１の切り替え制御を行う制

御回路１５、各波長の光信号を合波する波長多重素子１３、波長多重光信号を２分岐して光伝送路２－１，２－２に送信する光分岐素子１４により構成される。

【００２２】波長多重光信号受信装置３は、光伝送路２－１，２－２から受信する波長多重光信号の一方を選択出力する光信号切替回路３１、波長多重光信号を各波長の光信号に分波する波長多重分離素子３２、波長λ１～λ４の光信号を受信する受信回路３３（以下「Ｒ１～Ｒ４」という）、受信回路Ｒ１～Ｒ４から出力される受信信号を出力ポート①～③に接続する信号切替回路３４、受信回路Ｒ１～Ｒ４のモニタ部に接続され、さらに波長λ０の制御チャネルを介して波長多重光信号送信装置１に接続され、光信号切替回路３１および信号切替回路３４の切り替え制御を行う制御回路３５により構成される。

【００２３】なお、光伝送路２－１，２－２には、必要に応じて光増幅中継装置を挿入してもよい。また、ここでは光伝送路を二重化した構成を示したが、３以上の光伝送路に並列に送信するようにしてもよく、その場合には２入力２出力の光分岐素子１４に代えて１入力ｍ出力（ｍは３以上の整数）の光分岐素子（光スターカプラ）を用いればよい。

【００２４】図２は、第１の実施形態における障害発生時の制御例を示す。障害発生およびその検出形態としては、(1) 特定波長に障害が発生し、波長多重光信号送信装置１の送信回路１２で検出する場合、(2) 特定波長に障害が発生し、波長多重光信号受信装置３の受信回路３３で検出する場合、(3) 現用系の光伝送路２に障害が発生し、波長多重光信号受信装置３の受信回路３３で検出する場合がある。

【００２５】まず、現用系として、入力ポート①～③の送信信号を送信回路Ｔ１～Ｔ３で波長λ１～λ３の光信号に変換し、光伝送路２－１を介して伝送し、波長λ１～λ３の光信号を受信回路Ｒ１～Ｒ３で受信し、各受信信号を出力ポート①～③に出力する状態が設定されているものとする。

【００２６】(1) 送信回路Ｔ１で波長λ１の障害発生
送信回路Ｔ１のモニタ部は、波長λ１の障害を検出して制御回路１５に通知する。制御回路１５は現在空いている波長を調べ、信号切替回路１１を制御して入力ポート①の送信信号を送信回路Ｔ１から送信回路Ｔ４に切り替え、波長λ４の光信号として送信する。また、制御回路１５は、入力ポート①の送信信号が波長λ１からλ４に切り替わったことを示す切替制御情報を波長λ０の制御チャネルを用いて波長多重光信号受信装置３の制御回路３５に通知する。制御回路３５は、この切替制御情報に応じて信号切替回路３４を制御し、出力ポート①との接続を受信回路Ｒ１から受信回路Ｒ４に切り替え、波長λ４の光信号を受信する。以上の切り替え状態を図１の信号切替回路１１，３４に破線で示す。

【００２７】(2) 光伝送路２－１または受信回路Ｒ１で波長λ１の障害発生
受信回路Ｒ１のモニタ部は、波長λ１の障害を検出して制御回路３５に通知する。制御回路３５は現在空いている波長を調べ、信号切替回路３４を制御して出力ポート①との接続を受信回路Ｒ１から受信回路Ｒ４に切り替え、波長λ４の光信号を受信する。また、制御回路３５は、出力ポート①との接続が受信回路Ｒ１から受信回路Ｒ４に切り替わったことを示す切替制御情報を波長λ０の制御チャネルを用いて波長多重光信号送信装置１の制御回路１５に通知する。制御回路１５は、この切替制御情報に応じて信号切替回路１１を制御し、入力ポート①の送信信号を送信回路Ｔ１から送信回路Ｔ４に切り替え、波長λ４の光信号として送信する。以上の切り替え状態を図１の信号切替回路１１，３４に破線で示す。

【００２８】(3) 光伝送路２－１で障害発生
受信回路Ｒ１～Ｒ３のモニタ部は、波長λ１～λ３の障害をそれぞれ検出して制御回路３５に通知する。制御回路３５は、すべての波長の障害から光伝送路２－１の障害と判断し、光信号切替回路３１を制御して光伝送路２－１から光伝送路２－２への接続に切り替える。これにより、光伝送路２－２を介して伝送された波長λ１～λ３の光信号が受信回路Ｒ１～Ｒ３に受信される。以上の切り替え状態を図１の光信号切替回路３１に破線で示す。

【００２９】このように、本実施形態の光波長多重伝送システムは、１組の波長多重光信号送信装置１および波長多重光信号受信装置３により、光伝送路のバックアップを可能にし、さらに波長単位のバックアップにも対応することができる。なお、本実施形態では、波長λ４を空きチャネルとして確保しておいたが、通常時は他の信号の伝送に用い、波長λ１～λ３の信号に障害が発生したときに他の信号を停止し、波長λ１～λ３の信号のバックアップとして利用するようにしてもよい。

【００３０】（第２の実施形態）図３は、本発明の光波長多重通信システムの第２の実施形態を示す。図において、本システムは、波長多重光信号送信装置１と、光伝送路２－１，２－２と、波長多重光信号受信装置３により構成される。ここでは、送受信装置間の制御チャネルとして波長λ０を用い、入力ポート①～④の送信信号を波長λ１～λ４を用いて伝送し、出力ポート①～④に出力するものとする。

【００３１】波長多重光信号送信装置１は、入力ポート①の送信信号を波長λ１の光信号に変換する送信回路Ｔ１、入力ポート②の送信信号を波長λ２の光信号に変換する送信回路Ｔ２、入力ポート③の送信信号を波長λ３の光信号に変換する送信回路T31，T32、入力ポート④の送信信号を波長λ４の光信号に変換する送信回路T41，T42、送信回路T31とT32、T41とT42のそれぞれ一方を駆動制御し、波長λ０の制御チャネルを介して波

長多重光信号受信装置３に接続される制御回路１５、各波長の光信号をそれぞれ２分岐する光分岐素子１４、２分岐された各波長の光信号をそれぞれ合波して光伝送路２－１，２－２に送信する波長多重素子１３－１，１３－２により構成される。

【００３２】波長多重光信号受信装置３は、光伝送路２－１，２－２から受信する波長多重光信号をそれぞれ各波長の光信号に分波する波長多重分離素子３２－１，３２－２、各波長の光信号を受信回路Ｒ１～Ｒ４および制御回路３５に接続する光信号切替回路３１、波長λ１～λ４の光信号を受信して出力ポート①～④に出力する受信回路Ｒ１～Ｒ４、受信回路Ｒ１～Ｒ４のモニタ部に接続され、さらに波長λ０の制御チャネルを介して波長多重光信号送信装置１に接続され、光信号切替回路３１の切り替え制御を行う制御回路３５により構成される。

【００３３】なお、光伝送路２－１，２－２には、必要に応じて光増幅中継装置を挿入してもよい。また、ここでは光伝送路を二重化した構成を示したが、３以上の光伝送路に並列に送信するようにしてもよく、その場合には２入力２出力の光分岐素子１４に代えて１入力m出力（mは３以上の整数）の光分岐素子（光スターカプラ）を用い、各光伝送路に対応する波長多重素子１３－１～１３－nを用いる。また、本実施形態の波長多重光信号受信装置３は、第１の実施形態の波長多重光信号受信装置３から信号切替器３４を除いた構成のものと入れ替えてもよい。

【００３４】本実施形態は、波長λ３の送信回路T31，T32、波長λ４の送信回路T41，T42がそれぞれ二重化され、通常はその一方が動作し、その障害時に他方の動作に切り替えるように制御回路１５が制御する。そのいずれかから出力される波長λ３，λ４の光信号は、２入力２出力の光分岐素子１４を介して波長多重素子１３－１，１３－２に分岐され、光伝送路２－１，２－２に並列に送信される。

【００３５】一方、光伝送路２－１に障害が発生し、受信回路Ｒ１～Ｒ４で検出した場合には、制御回路３５は、光信号切替回路３１を制御して波長多重分離素子３２－２で分離された各波長の光信号との接続に切り替える。これにより、光伝送路２－２を介して伝送された波長λ１～λ４の光信号が受信回路Ｒ１～Ｒ４に受信される。

【００３６】このように、本実施形態の光波長多重伝送システムは、１組の波長多重光信号送信装置１および波長多重光信号受信装置３により、光伝送路のバックアップを可能にし、さらに一部の波長の送信回路のバックアップにも対応することができる。

【００３７】（第３の実施形態）図４は、本発明の光波長多重通信システムの第３の実施形態を示す。図において、本システムは、波長多重光信号送信装置１と、光伝送路２－１，２－２と、波長多重光信号受信装置３により構成される。ここでは、送受信装置間の制御チャネルとして波長λ０を用い、入力ポート①～⑥の送信信号を波長λ１～λ４を用いて伝送し、出力ポート①～⑥に出力するものとする。また、入力ポート①，②の送信信号については２分岐して伝送することにより光伝送路における冗長性を有し、入力ポート③～⑥の送信信号については信号切り替えにより光伝送路および信号間の冗長性を確保する。また、光伝送路２－１，２－２には、必要に応じて光増幅中継装置を挿入してもよい。

【００３８】波長多重光信号送信装置１は、入力ポート③～⑥の送信信号を送信回路Ｔ３～Ｔ６に接続する信号切替回路１１、入力ポート①の送信信号を波長λ１の光信号に変換する送信回路Ｔ１、入力ポート②の送信信号を波長λ２の光信号に変換する送信回路Ｔ２、波長λ３の光信号を出力する送信回路Ｔ３，Ｔ５、波長λ４の光信号を出力する送信回路Ｔ４，Ｔ６、送信回路Ｔ３～Ｔ６のモニタ部に接続され、さらに波長λ０の制御チャネルを介して波長多重光信号受信装置３に接続され、信号切替回路１１の切り替え制御を行う制御回路１５、波長λ０～λ２の光信号をそれぞれ２分岐する光分岐素子１４、２分岐された一方の波長λ０～λ２の光信号および送信回路Ｔ３，Ｔ４から出力される波長λ３，λ４の光信号を合波して光伝送路２－１に送信する波長多重素子１３－１、２分岐された他方の波長λ０～λ２の光信号および送信回路Ｔ５，Ｔ６から出力される波長λ３，λ４の光信号を合波して光伝送路２－２に送信する波長多重素子１３－２により構成される。

【００３９】ここで、送信回路Ｔ１，Ｔ２（λ１，λ２）は、請求項３，４における第１の光信号送信手段に対応し、送信回路Ｔ３～Ｔ６（λ３，λ４）は、請求項３，４における第２の光信号送信手段に対応し、ｎ＝２の場合に対応する。なお、第１の光信号送信手段および第２の光信号送信手段の波長がそれぞれ１つあるいは３つ以上であってもよい。

【００４０】波長多重光信号受信装置３は、光伝送路２－１，２－２から受信する波長多重光信号をそれぞれ各波長の光信号に分波する波長多重分離素子３２－１，３２－２、各波長の光信号を受信回路Ｒ１～Ｒ６および制御回路３５に接続する光信号切替回路３１、波長λ１，λ２の光信号を受信して出力ポート①，②に出力する受信回路Ｒ１，Ｒ２、波長λ３の光信号を受信する受信回路Ｒ３，Ｒ５、波長λ４の光信号を受信する受信回路Ｒ４，Ｒ６、受信回路Ｒ３～Ｒ６から出力される受信信号を出力ポート③～⑥に接続する信号切替回路３４、受信回路Ｒ１～Ｒ６のモニタ部に接続され、さらに波長λ０の制御チャネルを介して波長多重光信号送信装置１に接続され、光信号切替回路３１および信号切替回路３４の切り替え制御を行う制御回路３５により構成される。

【００４１】本構成では、入力ポート①～④の送信信号は、それぞれ波長λ１～λ４の光信号として光伝送路２

－１を介して伝送され、出力ポート①～④に出力される。また、入力ポート⑤，⑥の送信信号は、それぞれ波長λ３，λ４の光信号として光伝送路２－２を介して伝送され、出力ポート⑤，⑥に出力される。このとき、入力ポート①，②の送信信号は、波長λ１，λ２の光信号として光伝送路２－１，２－２を並列に伝送されており、光信号切替回路３１の切り替えにより光伝送路２－１，２－２のいずれかを選択して受信回路Ｒ１，Ｒ２に受信できる。すなわち、光伝送路２－１に障害が発生した場合に、入力ポート①，②の送信信号については、図４に破線で示すように光信号切替回路３１の切り替えによりバックアップが可能になっている。また、光伝送路２－１の光増幅中継装置などで波長λ１，λ２の光信号に障害が発生した場合には、同様に光伝送路２－２に迂回することにより復旧が可能である。ただし、送信回路Ｔ１，Ｔ２および受信回路Ｒ１，Ｒ２にバックアップはないので、その障害復旧はできない。

【００４２】一方、本構成は、入力ポート③～⑥の送信信号について光伝送路のバックアップを設けていない。ただし、各信号に優先順位を設け、障害発生時には優先順位の低い信号の伝送を中止し、その送受信回路を利用して優先順位の高い信号の伝送を行うことにより、光伝送路や各光信号のバックアップが可能になる。以下、この障害発生時の制御例について図５～７を参照して説明する。

【００４３】(1) 光伝送路２－１に障害が発生した場合
図５は、光伝送路２－１に障害が発生した場合に、入力ポート①～④の送信信号の復旧例を示す。入力ポート①，②の送信信号および制御チャネルについては、上記のように光信号切替回路３１の切り替えにより、光伝送路２－２を用いるバックアップが可能になっている。

【００４４】ここで、入力ポート③，④の送信信号の優先順位は、入力ポート⑤，⑥の送信信号の優先順位よりも高いとする。光伝送路２－１の障害により、入力ポート③，④の送信信号を光信号に変換する送信回路Ｔ３，Ｔ４は使用できない。そこで、制御回路１５は信号切替回路１１を制御し、入力ポート⑤，⑥の送信信号に代わり、入力ポート③，④の送信信号を送信回路Ｔ５，Ｔ６に接続する。これにより、入力ポート①～④の送信信号は、波長λ１～λ４の光信号として光伝送路２－２を介して波長多重光信号受信装置３に伝送される。信号切替回路１１の切替制御情報は、制御回路１５から波長多重光信号受信装置３の制御回路３５に通知される。

【００４５】波長多重光信号受信装置３では、制御回路３５が光信号切替回路３１を制御し、波長多重分離素子３２－２で分波された波長λ１～λ４の光信号を受信回路Ｒ１～Ｒ４に接続することにより、出力ポート①～④に各受信信号が出力される。なお、波長λ３，λ４の光信号については、図中破線で示すように受信回路Ｒ５，Ｒ６で受信し、信号切替回路３４の切り替えにより出力ポート③，④に接続するようにしてもよい。

【００４６】(2) 送信回路Ｔ３に障害が発生した場合
図６は、送信回路Ｔ３に障害が発生した場合に、入力ポート③の送信信号の復旧例を示す。ここで、入力ポート③，④の送信信号の優先順位は、入力ポート⑤，⑥の送信信号の優先順位よりも高いとする。

【００４７】送信回路Ｔ３のモニタ部は、波長λ３の障害を検出して制御回路１５に通知する。制御回路１５は、信号切替回路１１を制御して入力ポート③の送信信号より優先順位の低い入力ポート⑤の送信信号の接続を中止し、入力ポート③の送信信号を送信回路Ｔ３から送信回路Ｔ５に切り替え、光伝送路２－２を介して伝送する。また、制御回路１５は、入力ポート③の送信信号が光伝送路２－２に切り替わったことを示す切替制御情報を波長λ０の制御チャネルを用いて波長多重光信号受信装置３の制御回路３５に通知する。制御回路３５は、この切替制御情報に応じて光信号切替回路３１を制御し、波長λ３の光信号を受信回路Ｒ５から受信回路Ｒ３に切り替えて受信させる。これにより、入力ポート③の送信信号は出力ポート③に出力される。なお、波長λ３の光信号については、図中破線で示すように受信回路Ｒ５で受信し、信号切替回路３４の切り替えにより出力ポート③に接続するようにしてもよい。

【００４８】(3) 受信回路Ｒ３に障害が発生した場合
図７は、受信回路Ｒ３に障害が発生した場合に、入力ポート③の送信信号の復旧例を示す。ここで、入出力ポート③，④の送受信信号の優先順位は、入出力ポート⑤，⑥の送受信信号の優先順位よりも高いとする。

【００４９】受信回路Ｒ３のモニタ部は、波長λ３の障害を検出して制御回路３５に通知する。制御回路３５は、光信号切替回路３１および信号切替回路３４を制御し、出力ポート③の受信信号より優先順位の低い出力ポート⑤の受信信号の接続を中止し、波長λ３の光信号を受信回路Ｒ３から受信回路Ｒ５に切り替えて受信し、出力ポート③に出力する。これにより、入力ポート③の送信信号は出力ポート③に出力される。

【００５０】(4) 波長λ３に障害が発生し、受信回路Ｒ３で検出した場合
図８は、波長λ３に障害が発生し、受信回路Ｒ３で検出した場合に、入力ポート③の送信信号の復旧例を示す。ここで、入出力ポート③，④の送受信信号の優先順位は、入出力ポート⑤，⑥の送受信信号の優先順位よりも高いとする。

【００５１】受信回路Ｒ３のモニタ部は、光伝送路２－１の光増幅中継器等による波長λ３の障害を検出し、制御回路３５に通知する。制御回路３５は、信号切替回路３４を制御して出力ポート③の受信信号より優先順位の低い出力ポート⑤の受信信号の接続を中止し、出力ポート③との接続を受信回路Ｒ３から受信回路Ｒ５に切り替える。また、制御回路３５は、出力ポート③との接続が

受信回路Ｒ３から受信回路Ｒ５に切り替わったことを示す切替制御情報を波長λ０の制御チャネルを用いて波長多重光信号送信装置１の制御回路１５に通知する。制御回路１５は、この切替制御情報に応じて信号切替回路１１を制御し、入力ポート③の送信信号を送信回路Ｔ３から送信回路Ｔ５に切り替え、波長λ３の光信号として送信する。これにより、入力ポート③の送信信号は出力ポート③に出力される。なお、波長λ３の光信号については、図中破線で示すように光信号切替回路３１の切り替えにより受信回路Ｒ３で受信し、出力ポート③に接続するようにしてもよい。

【００５２】（第４の実施形態）以上説明した実施形態は、波長多重光信号送信装置１と波長多重光信号受信装置３が、光伝送路２－１，２－２を介して対向配置される構成になっている。すなわち、図９(1) に示す隣接するノード６－１，６－３間で光伝送路を二重化した構成になっている。ここで、図９(2) に示すように、例えば光伝送路２－２の経路に、波長多重光信号受信装置３と波長多重光信号送信装置１を含むノード６－２を挿入することにより、光伝送路２－１のバックアップとして光伝送路２－２、ノード６－２、光伝送路２－３を介する経路を設定することができる。

【００５３】このように一般的なネットワークにおいて、ノードを構成する送信装置および受信装置として、上述した各実施形態の波長多重光信号送信装置１および波長多重光信号受信装置３を利用することにより、波長多重光信号の中のある波長の光信号に障害が発生した場合には予備波長に切り替え、光伝送路に障害が発生した場合には予備光伝送路に切り替える構成を実現することができる。

【００５４】なお、他のノードを介するマルチホップの経路では、各経路で使用する帯域を共用することになり、それぞれが使用できる帯域に制限が加わるので、バッファなどを用いて帯域制限に対応する必要がある。また、帯域変動を考慮して経路の選択を行うには、上位レイヤでの判断が適している。そこで、通信を運用するオペレーションシステムが信号経路を把握し、その変更情報を上位レイヤの装置に通知し、上位レイヤが最適な経路を決定することにより、効率的な通信システムを実現することができる。この上位レイヤとしてＩＰ(Internet Protocol) を使用している場合、通信経路を決定するルータは伝送路の使用料金、混雑状況等を把握して各通信データの経路を決定している。したがって、オペレーションシステムからの通知により、各ルータ間の経路のパラメータを変更し、最適な経路を選択することにより、効率的な通信を実現することができる。

【００５５】

【発明の効果】以上説明したように、本発明の波長多重光信号送信装置、波長多重光信号受信装置および光波長多重通信システムは、波長多重光信号の中のある波長の光信号に障害が発生した場合には予備波長に切り替え、光伝送路に障害が発生した場合には予備光伝送路に切り替える構成を低コストで実現することができる。

【図面の簡単な説明】

【図１】本発明の光波長多重通信システムの第１の実施形態を示す図。

【図２】第１の実施形態における障害発生時の制御例を説明する図。

【図３】本発明の光波長多重通信システムの第２の実施形態を示す図。

【図４】本発明の光波長多重通信システムの第３の実施形態（光伝送路２－１障害時の①，②の復旧例）を示す図。

【図５】本発明の光波長多重通信システムの第３の実施形態（光伝送路２－１障害時の①～④の復旧例、⑤，⑥中止）を示す図。

【図６】本発明の光波長多重通信システムの第３の実施形態（送信回路Ｔ３障害時の③の復旧例、⑤中止）を示す図。

【図７】本発明の光波長多重通信システムの第３の実施形態（受信回路Ｒ３障害時の③の復旧例、⑤中止）を示す図。

【図８】本発明の光波長多重通信システムの第３の実施形態（λ３障害、Ｒ３検出時の③の復旧例、⑤中止）を示す図。

【図９】本発明の光波長多重通信システムの第４の実施形態を示す図。

【図１０】従来の光通信システムの構成例を示す図。

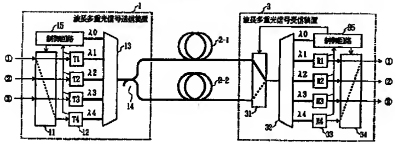
【図１１】従来の光波長多重通信システムの構成例を示す図。

【符号の説明】

１　波長多重光信号送信装置
２　光伝送路
３　波長多重光信号受信装置
４，５　切替器
６　ノード
１１　信号切替回路
１２　送信回路（Ｔ１～Ｔ６、T31～T42)
１３　波長多重素子
１４　光分岐素子
１５　制御回路
３１　光信号切替回路
３２　波長多重分離素子
３３　受信回路（Ｒ１～Ｒ６）
３４　信号切替回路
３５　制御回路

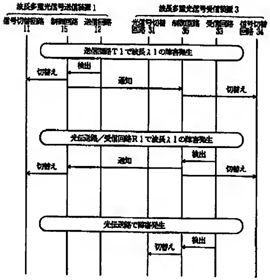
【図１】

本発明の光波長多重通信システムの第１の実施形態



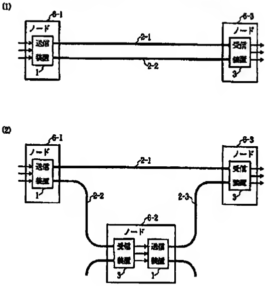
【図２】

第１の実施形態における障害発生時の制御例



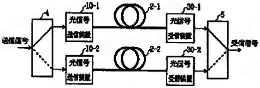
【図９】

本発明の光波長多重伝送システムの第４の実施形態



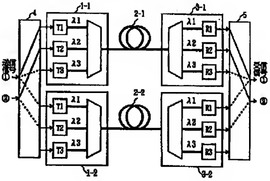
【図１０】

従来の光通信システムの構成例



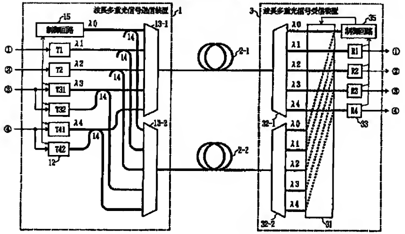
【図１１】

従来の光波長多重通信システムの構成例



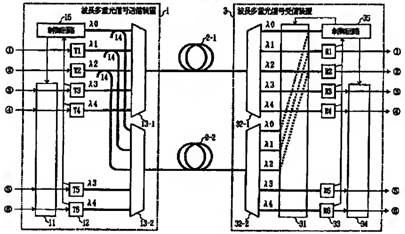
【図３】

本発明の光波長多重通信システムの第２の実施形態



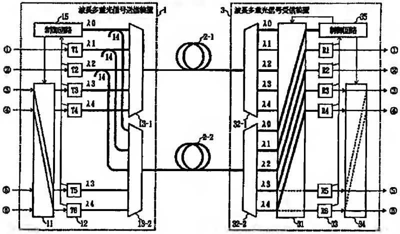
【図４】

本発明の光波長多重通信システムの第３の実施形態（光伝送路2-1 障害時の①、②の復旧例）



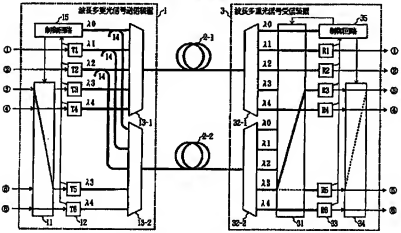
【図５】

本発明の光波長多重通信システムの第３の実施形態（光伝送路2-1 障害時の①～④の復旧例、⑤、⑥中止）



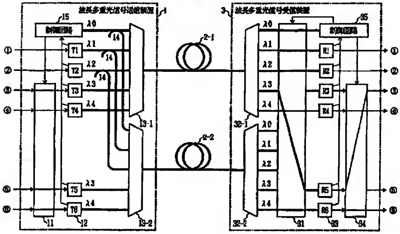
【図６】

本発明の光波長多重通信システムの第３の実施形態（送信回路Ｔ３障害時の③の復旧例、⑤中止）



【図７】

本発明の光波長多重通信システムの第３の実施形態（受信回路Ｒ３障害時の③の復旧例、⑤中止）



【図８】

本発明の光波長多重通信システムの第３の実施形態（λ３障害、Ｒ３検出時の③の復旧例、⑤中止）